Urban Evolution: the Role of Water

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Abstract

The structure, function, and services of urban ecosystems evolve over time scales from seconds to centuries as Earth's population grows, infrastructure ages, and sociopolitical values alter them. In order to systematically study changes over time, the concept of "urban evolution" was proposed. Here, we define and review a glossary of core concepts for studying urban evolution, which includes the mechanisms of urban selective pressure and urban adaptation. Urban selective pressure is an environmental or societal force contributing to urban adaptation, a directional process by which urban structure, function, and services becomes better fitted to its changing environment or human choices. The role of water is vital to driving urban evolution as demonstrated by historical changes in drainage, sewage flows, hydrologic pulses, and long-term chemistry. Hydrologic traits evolve across successive generations of urban ecosystems via shifts in selective pressures and adaptations over time. We explore multiple empirical examples including: (1) evolving urban drainage from stream burial to stormwater management, (2) evolving sewage in response to wastewater treatment, (3) evolving amplification of hydrologic pulses due to urbanization and climate, and (4) evolving salinization and alkalinization of fresh water. Finally, we propose a new conceptual model for the urban evolution of water from the Industrial Revolution to present day based on empirical trends and historical information. Ultimately, we propose that water itself is a critical driver of urban evolution constantly forcing urban adaptations, which transforms the structure, function, and services of urban landscapes, waterways, and civilizations over time.